STUDIES ON THE RESPONSES OF PEA VARIETIES TO CHEMICAL TREATMENT OF THE SEED

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INTRODUCTION

The production of peas on a commercial scale is relatively new to Alberta, but the areas devoted to this crop are rapidly increasing in the irrigated areas of the province and in a few of the dry land farming sections.

Peas are grown for two main purposes in southern Alberta, namely for canning and for a seed supply for the canners in eastern Canada and British Columbia. A small acreage is grown of the marrow fat varieties and a small acreage for forage purposes.

The canning industry has increased rapidly in eastern Canada and in British Columbia during the past few years, and is starting in Alberta. The rapid increase in the canning industry has been accompanied by an increase in the number of varieties of peas being developed for the canning trade. It has been shown that planting peas at different dates does not extend the canning season to any extent as all plantings will be ready for the viner about the same time, but with a corresponding decrease in yield for the later plantings. This has led to the development

of varieties, such that all can be sown at the same time, each having a natural maturity period longer than the preceding to enable harvesting at the most advantageous stage for canning of quality peas.

Many varieties are required to meet the tastes of the consumers of peas. Different flavors, sizes, colors and many other factors influence the sale of the canned product. Yield is a major factor to be considered in the breeding of new varieties, and as a result a large number of varieties have been developed. The canners, however, do not concern themselves with the development of these new varieties, but relegate this to the seedsmen.

The ideal climate and favorable location have made the irrigated areas of southern Alberta exceptionally well adapted to the production of seed peas, and the acreage devoted to this phase of the industry is rapidly increasing.

Although losses from disease have been light as yet, due probably to the industry being young, appreciable losses have been encountered in the pea fields from root-rot and other diseases in Alberta. In addition, various forms of foot- and seed-rot have been responsible for thinning out stands. The rank growth of the pea plant soon appears to fill in gaps caused by the thinning of the stand, however, and the loss due to this cause is not generally appreciated.

A large number of varieties are grown by the seed companies in this area, a number of which have been observed

to suffer to a much greater extent from seed- and foot-rot than do others. Some of the chemicals used for seed treatment at the present time, however, have very effectively controlled this form of disease, and as a result of the advances in this respect losses to seed growers and canners from the various seed- and foot-rotting organisms may be greatly reduced.

LITERATURE REVIEW

1. Varietal Differences

Under Alberta conditions a number of varieties appeared to suffer to a greater extent than others from seed- and foot-rot.

Some workers have indicated that certain varieties of peas are more resistant to seed- and foot-rot than others. Gilchrist (7) noted a variation in the amount of cuticle in the epicotyl and higher nodes and from the top of the epicotyl to its base at the point of attachment to the seed, an increase in amount of cuticle passing up from the base. He found varieties which were more susceptible to infection from Ascochyta sp. had no cuticle at the base of the epicotyl, whereas resistant varieties like Alaska and Horsford had a small amount of cuticle present. Jones (15) states that Surprise showed a much

greater susceptibility to basal stem injury by Mycosphaerella pinodes than Horsford Market Garden. Horsford Market Garden proved resistant to the three organisms Ascochyta pisi, Ascochyta pinodella and Mycosphaerella pinodes, while Perfection and Advancer were only slightly susceptible. Environment appeared to influence the severity of injury.

Jones (14) also found that the applications of water to the soil soon after planting reduced the percentage of germination of untreated pea seed, and that this reduction was greater with the sweet wrinkled varieties than with the Alaska varieties. He found that an increase in germination resulted from treating seed with Semesan dust under various soil moisture conditions and soil temperatures. But in general the sweet wrinkled varieties were more benefitted than was the Alaska variety. With the Alaska variety a good stand of plants was insured as a result of treatment regardless of moisture or temperature conditions. Seed treatment with a mercury dust Semesan (15) increased the height and vigor of stands and gave a marked reduction in the number of plants having foot-rot caused by Ascochyta pinodella or Mycosphaerella pinodes. Other workers (2) have observed similar results.

Corn varieties show differences in response to the same seed treatment (11, 25). Starr, from his work at Minnesota, reports that sometimes no benefits were obtained from treatment of corn seed, and even decreases in yield were obtained. He suggests that the weather conditions

following planting were the most important factor in this respect, although condition of the seed, and location of the trials may be of some importance. He found differences in varietal response varied with locality and season, but in general that Semesan Jr. shortened the germinating period of sweet corn varieties.

Barley also has been shown to exhibit varietal differences in response to seed treatment (21, 27). Dillon Weston, Hanley and Booer (6) observed an increase in the speed of "brairding" in barley, but not in the final population. The hastened seedling growth did not increase yields. Their results indicate that the different organic dusts did not speed up "brairding" of all cereals to the same extent.

Skaptason (24) noted a difference in response of varieties of wheat to seed treatment with formaldehyde. Varieties of oats and barley exhibited a similar varietal response to treatment with formaldehyde.

Peas (12) have been observed to give marked response to seed treatment with Red Copper Oxide in greenhouse experiments, and accelerated emergence was observed in the Perfection variety.

2. Organic Mercury Compounds for Seed Treatment

The organic mercury compounds were used first as disinfectants in medicine. In 1912 organic mercury

compounds were introduced as seed disinfectants in Germany. Riehm (22, 23) along with others found them effective in cereal disease control.

The first of the mercury compounds for seed treatment to be placed on the market was a chlorophenol mercury compound known as "Uspulun", introduced in 1915. Similar compounds appeared in the United States in 1921 under trade names "Chlorophol" and "Semesan". In the early stages these organic materials were all used as "wet treatments".

In 1922 (4) organic mercury dusts were used experimentally in the United States and various compounds appeared on the market. In 1927 ethyl mercury chloride was put on the market as Ceresan and in 1931 ethyl mercury phosphate was brought out as New Improved Ceresan. Dillon Weston and Booer at Cambridge in England (5) investigated a range of mercury compounds to produce an effective seed disinfectant of known composition, following which two mercury compounds "Standard Leytosan" and "Leytosan P" were put on the market in England in 1934 which, with New Improved Ceresan, have gradually been replacing most other forms of seed disinfectants in Canada.

For such seeds as flax and peas, etc., the dust fungicides are of exceptional value, and although liquid fungicides are by no means discarded for other grains they are gradually being replaced by the mercury dust seed treatments.

Many claims of stimulation have been made for mercurial dusts, but Dillon Weston and Booer (5) found no evidence of stimulation in the sense of a tonic effect. They suggest that the noticeably better germination, crop growth and yield are due not only to the control of seed-borne diseases but to the preservation of the food reserves in the seed from the attack of soil organisms. Brett, Dillon Weston, Booer (3) state this work indicates that the effect of the fungicidal dusts used in their experiments is due to the protection of the cotyledons from the depredations of soil organisms, thus maintaining a relatively high proportion of the food materials for the developing plantlets. Although it might be inferred from their results that the effect of such dusts was one of stimulation, in controlled experiments in sterile media with a number of different seed species they have never obtained any significant stimulation, and are of the opinion that any effect which might be interpreted as stimulation is due entirely to the protection afforded to the seed and its food reserves.

OBJECTS OF THE INVESTIGATION

The purpose of this investigation was primarily to determine whether varieties of garden and canning peas respond differently to seed treatment with Leytosan P, and to determine if possible the reasons for any difference found. Also to determine the relative fungicidal or

protective value of Leytosan P and New Improved Ceresan for different varieties of peas against soil and seed-borne parasites of which a number are known to cause seed and foot-rot of the pea (3, 7, 13, 14, 15).

MATERIALS AND METHODS

The Leytosan P used in this work was very kindly donated by Hockin & Dougherty Limited, Vancouver agents for F. W. Berk & Company, Limited, London, England. It contains 3% mercury present as methyl mercury dihydrogen phosphate ($CH_3HgH_2PO_4$) with the inert filler of china clay (kaolin). Professor Burn of the Pharmaceutical Society of Great Britain describes relative toxicity tests on mice by oral administration and fixes the relative toxicity of this methyl mercury phosphate as 1.6 times that of corrosive sublimate (mercuric chloride, $HgCl_2$). Leytosan P contains 4.7% methyl mercury phosphate which makes it roughly 1/10th as toxic as mercuric chloride.

The manufacturers regard the fungicidal power of this mercurial dust as something that depends upon local conditions. But they state that the methyl mercury compounds, as a whole, are by far the most fungicidal compounds they have met.

The New Improved Ceresan used in this work is an ethyl mercury phosphate, the ethyl mercury phosphate totalling 5% with the mercury equivalent of 3.8%. The inert ingredients total 95%.

The seed was obtained from a single source, where conditions of production were as nearly the same as is possible under large scale production. Thanks are due here to the Grimm Alfalfa Seed Growers of Alberta, Limited, at Brooks, who so kindly donated the seed for this investigation. This Company operates at Brooks in the Eastern Irrigation Project in southern Alberta where all seed is grown with irrigation, the rainfall being extremely light during the months of June, July, August and September. Official germination tests by the Dominion Seed Branch show all varieties used in this work to have a germination rating over 90%.

For all field tests at Brooks, the seed was treated one week prior to seeding, at the rate of 2 ounces per bushel with Leytosan P and ½ ounce per bushel with New Improved Ceresan. The small seed lots for the trial plot tests were shaken up in a glass stoppered flask with the required amount of dust for a few minutes, then any excess dust removed and the seed stored in envelopes until seeding time. For the large scale field trials, the seed was treated in the large seed treater which the Grimm Alfalfa Seed Company uses for treating cereal grains commercially with standard Leytosan. This machine consists of a large steel barrel of ten bushel capacity, fitted with baffles to insure a thorough mix of the grain and mercury dust. The barrel revolves on a shaft from power supplied by a ½ horse power dynamo. The seed was treated and stored in strong Bemis white cotton bags until seeding time.

For the greenhouse trials at the University of Alberta the seed was shaken up in a glass stoppered flask with the required quantity of dust and placed in envelopes for 48 hours prior to seeding.

The tests in the greenhouse were made in three parts Edmonton soil, a heavy black loam, and one part sand. All tests were conducted in non-sterile soil, with the exception of those in which it is specifically mentioned that sterilized soil was used. The temperatures were thermostatically controlled. Artificial light was supplied in the experiment to observe the effect of seed treatment on plant growth. The artificial light was supplied from dusk at 5 o'clock to 12 o'clock at night.

THE RELATIVE RESPONSES OF PEA VARIETIES TO SEED TREATMENT IN THE FIELD

Field trials were conducted at Brooks and at Edmonton. The Brooks area is located in the dry belt of southern Alberta where the moisture is supplied by irrigation. The soil here is a light brown loam. The soil at Edmonton is a heavy black loam located in an area of considerable rainfall. The season is approximately two weeks earlier at Brooks than at Edmonton.

Trial Plot Tests with Two Mercury Dusts at Brooks

The following twelve varieties were selected for the trials at Brooks:

Tall Telephone
Daisy
Stratagem
Thomas Laxton
Laxton Progress
Surprise

Horsford
Perfection
Hundredfold
Little Marvel
Alaska
Lincoln

The first six varieties showed varying degrees of injury from seed- and foot-rot at Brooks, while the second six showed relatively little damage from this cause at Brooks.

Experimental Method.

Nine hundred seeds of each variety were sown, 300 treated with Leytosan P, 300 seeds with New Improved Ceresan, and 300 seeds used for a control. The seeds were sown 2 inches deep, 100 seeds per 12-foot row, three rows of each constituting a plot (Figure 1). The seed was treated with Leytosan P at the rate of 2 ounces per bushel, and with New Improved Ceresan at the rate of ½ ounce per bushel, one week prior to planting. The dust was added to the seed in a glass stoppered flask and thoroughly shaken up. The seed was then transferred to envelopes where it was left until ready for planting.

Figure 1

The thin ragged stand of a control plot of Stratagem is shown in the foreground with a thick luxuriant growth of Stratagem treated with Leytosan P in the background.

Figure 2

Omitting the first row, 3 three-rowed plots of Stratagem are shown above. The first treated with Leytosan P, the second with Ceresan and the third can be readily recognized as the control plot with its patchy stand.

The seed was sown in the following order: three rows of 100 seeds each treated with Leytosan P, three rows of seed treated with New Improved Ceresan, and three rows of seed not treated, as a control (Figure 2). Figures 3 and 4 picture the effect of seed treatment on Horsford and Tall Telephone varieties. The soil was quite moist at the time of planting on May 8th, and was well supplied with moisture throughout the growing season in the form of irrigation water. Three irrigations were ample to bring the plants through to maturity. A record of the rainfall with the maximum and minimum temperatures for the month of May are recorded in Table I.

Emergence counts were made for each plot, and the total emergence for each recorded and expressed as a percentage of the number of seeds sown per plot.

These data were not statistically analyzed, because the tests were not replicated. They have been presented here because they were considered of value in that they do indicate a varietal difference in response to seed treatment with mercury dusts under field conditions. Also the influence of locality and environment on seed treatment is indicated in later comparisons.

Experimental Results.

Table II presents the emergence data of the seed treated with Leytosan P, New Improved Ceresan and the controls in field trials at Brooks, expressed in percent.

Figure 3

From left to right in the foreground, one row of Horsford treated with Leytosan P, three rows with New Improved Ceresan and three control rows which are readily identified.

Figure 4

In the foreground are three rows of Tall Telephone treated with Leytosan P and two rows of the control plot are shown to the right.

TABLE I

Brooks - temperature and rainfall for May, 1936

Date	Temperature		Rainfall
	Maximum	Minimum	
1	74°F.	38	
2	70	37	
3	63	40	
4	85	43	
5	71	48	
6	51	44	.53"
7	69	34	
8	72	44	
9	77	37	
10	77	40	
11	48	39	.05
12	63	28	
13	77	35	
14	94	47	
15	76	55	
16	66	47	.01
17	61	46	.01
18	70	42	
19	79	42	.49
20	53	31	.62
21	65	40	
22	68	41	
23	79	42	
24	80	46	
25	90	49	
26	94	51	
27	92	54	
28	96	57	
29	92	58	
30	94	55	
31	85	60	.11

TABLE II

Comparative effect of seed treatment with Leytosan P and New Improved Ceresan on emergence at Brooks

Variety	Emergence per plot in %			Difference between		
	Leytosan P	New Improved Ceresan	Control	New Improved Ceresan and Leytosan P in %	New Improved Ceresan and control in %	Leytosan P and control in %
Tall Telephone	81.6	70.3	32.1	11.3	38.2	49.9
Stratagem	69.2	65.2	25.1	4.0	40.1	44.1
Daisy	62.4	62.4	25.9	0	36.6	36.6
Thomas Laxton	74.1	75.2	40.7	-1.1	34.5	33.4
Laxton Progress	70.8	71.6	42.2	-0.8	29.5	28.7
Surprise	62.0	65.1	38.8	-3.1	26.3	23.2
Hundredfold	59.0	60.8	36.2	-1.8	24.6	22.8
Perfection	70.6	79.4	56.5	-8.8	22.9	14.1
Horsford	69.2	75.4	57.0	-6.2	18.4	12.2
Lincoln	74.2	77.7	64.3	-3.5	13.3	9.9
Little Marvel	68.0	66.3	61.0	1.7	5.3	7.0
Alaska	68.3	76.0	76.2	-7.7	-0.2	-7.9

The emergence data show very little difference between seed treated with Leytosan P and New Improved Ceresan. All varieties used in this experiment responded to seed treatment with these two dusts in the same order, although individual varieties do exhibit differences in response, for example, Tall Telephone, Stratagem and Little Marvel respond to Leytosan P to a greater degree than to New Improved Ceresan. Daisy responded similarly to both, while all other varieties responded more to seed treatment with New Improved Ceresan, especially Horsford, Perfection and Alaska.

Table III shows the yields in pounds per plot. The yields do not seem to hold as close a relationship to emergence numbers in the New Improved Ceresan tests as in the tests with Leytosan P, with three exceptions, Horsford, Little Marvel and Lincoln. All varieties give a greater yield as a result of seed treatment with Leytosan P than with New Improved Ceresan, although the differences are not great.

TABLE III

Comparative effect of seed treatment with Leytosan P and New Improved Ceresan on yields at Brooks

Variety	Yield per plot in pounds			Difference between		
	Leytosan P	New Improved Ceresan	Control	New Improved Ceresan and Leytosan P in bu. per acre	New Improved Ceresan and control in bu. per acre	Leytosan P and control in bu. per acre
Daisy	3.9	3.3	1.9	4.0	9.4	13.5
Tall Telephone	4.0	3.3	2.2	4.5	7.3	12.1
Stratagem	3.5	2.7	2.0	5.4	4.5	10.1
Laxton Progress	2.7	2.1	1.7	4.0	2.7	6.7
Hundredfold	3.1	2.3	2.2	5.4	0.7	6.0
Thomas Laxton	2.4	2.1	1.6	2.0	3.4	5.4
Perfection	4.4	4.0	3.6	2.7	2.7	5.4
Surprise	2.6	2.5	2.0	0.7	3.4	4.0
Horsford	4.2	4.3	3.6	-0.7	4.5	4.0
Alaska	2.6	2.5	2.1	0.7	2.7	3.4
Little Marvel	2.9	3.0	2.7	-0.7	2.0	1.3
Lincoln	4.8	5.1	5.2	-2.0	-0.7	-2.7

Trial Plot Tests with Leytosan P at Brooks

The tests with Leytosan P at Brooks are considered separately here to facilitate comparison with similar tests conducted at the University of Alberta trial grounds under the direction of Dr. A. W. Henry at that institution. A statistical comparison was not possible, however, since the plots were not replicated nor laid out at Brooks in such a manner as to make this possible.

Experimental Results.

Table IV presents the emergence counts from plots where the seed was treated with Leytosan P, and the control plots, expressed in percent of the total number of seeds planted per plot.

It will be noted from Table IV that those six varieties previously observed to incur considerable damage from seed- and foot-rot in the field at Brooks, show a marked increase in emergence as a result of seed treatment with Leytosan P, whereas those varieties noticed to be more resistant to the attack of the seed- and foot-rotting organisms do not show a very great increase in emergence as a result of seed treatment; Alaska, in fact, shows a reduced emergence.

TABLE IV

Effect of seed treatment with Leytosan P
on emergence at Brooks

Variety	Average emergence in %		Difference in %
	Treated	Control	
Tall Telephone	81.6	32.1	49.5
Stratagem	69.2	25.1	44.1
Daisy	62.4	25.9	36.5
Thomas Laxton	74.1	40.6	33.5
Laxton Progress	70.9	42.2	28.7
Surprise	62.0	38.1	23.9
Hundredfold	59.0	36.2	22.8
Perfection	70.6	56.5	14.1
Horsford	69.2	57.0	12.2
Lincoln	74.2	64.3	9.9
Little Marvel	68.0	61.0	7.0
Alaska	68.3	76.2	-7.9

Table V presents the yield from the Leytosan P and control plots with the difference expressed in bushels per acre.

The varieties show a different individual order in emergence number to that of yield, although the general order is similar. Daisy, Tall Telephone and Stratagem give a marked response in yield over other varieties. Laxton Progress, Hundredfold, Thomas Laxton, Perfection, Surprise, Horsford and Alaska appear to be intermediate, while Little Marvel shows only a slight response. Lincoln shows a negative response.

TABLE V

Effect of seed treatment on yield at Brooks

Variety	Yield per plot in pounds		Difference in pounds	Difference in bushels per acre
	Leytosan P	Control		
Daisy	3.9	1.9	2.0	13.5
Tall Telephone	4.0	2.2	1.8	12.6
Stratagem	3.5	2.0	1.5	10.0
Laxton Progress	2.7	1.7	1.0	6.7
Hundredfold	3.1	2.2	0.9	6.0
Thomas Laxton	2.4	1.6	0.8	5.4
Perfection	4.4	3.6	0.8	5.4
Surprise	2.6	2.0	0.6	4.0
Horsford	4.1	3.6	0.5	3.4
Alaska	2.6	2.1	0.5	3.4
Little Marvel	2.9	2.7	0.2	1.3
Lincoln	4.8	5.2	-0.4	-2.7

Trial Plot Tests with Leytosan P at Edmonton

Table VI presents the emergence counts in the University trial grounds at Edmonton. These trials were conducted by Dr. Henry at the University of Alberta and consisted of 3-row plots replicated five times and randomized. Seed treatment was made in a similar manner to that at Brooks. The data were taken from the center rows of the plots. In the Edmonton trials five varieties were included, not included at Brooks, namely Alderman, Advancer, Laxton Superb, American Wonder and a field pea, Golden Vine.

TABLE VI

Effect of seed treatment with Leytosan P on emergence at Edmonton

Variety	Emergence in %		Increase in % due to seed treatment
	Leytosan P	Control	
Daisy	84.2	53.4	30.8
Stratagem	81.4	60.2	21.2
Laxton's Progress	90.0	74.0	16.0
Alderman	90.6	75.0	15.6
Surprise	83.4	67.8	15.6
Little Marvel	78.6	63.6	15.0
Hundredfold	90.0	76.4	13.6
Thomas Laxton	89.8	77.0	12.8
Tall Telephone	85.0	73.4	11.6
Perfection	85.2	74.8	10.4
American Wonder	84.6	74.8	9.8
Alaska	89.6	81.0	8.6
Laxton Superb	92.8	85.0	7.8
Horsford	91.8	86.0	5.8
Golden Vine	92.8	87.4	5.4
Lincoln	93.6	90.8	2.8
Advancer	90.2	88.6	1.6

The first 11 varieties indicated above gave significant increases in emergence when treated with Leytosan P.

To be significant the difference must exceed 8.8.

Comparing those varieties grown at Brooks with the same varieties grown at Edmonton, Little Marvel gave little response to the seed treatment at Brooks due primarily to the fact that it did not suffer from seed-rot to the extent that it does when grown at Edmonton. Tall Telephone gave a greater response to treatment when grown at Brooks than when grown at Edmonton for the same reason that the Little Marvel gave the greater response at

Edmonton. Alaska responds favorably at Edmonton, while at Brooks it shows a decreased emergence as a result of seed treatment.

Table VII presents the average yield in bushels per acre for the Edmonton trials. The Brooks yields exhibit marked differences between treated and non-treated plots for all varieties with the exception of Lincoln and Little Marvel, whereas differences in yields at Edmonton were significant for only Stratagem and Alderman, although there was considerable difference between treated and non-treated plots of Horsford, Tall Telephone and Daisy. Horsford at Edmonton gives a marked increase in yield, while the increased percent emergence was not great. Hundredfold exhibits a reduced yield, while the percent emergence was markedly increased. Alaska exhibits a reduced yield as a result of seed treatment at Edmonton, while at Brooks it responds favorably; the reverse is true for Lincoln, although the response at Edmonton is not very great. With one or two exceptions there appears, however, to be a general relationship in yield increase as a result of seed treatment between Edmonton and Brooks trials.

TABLE VII

Effect of seed treatment with Leytosan P on yield at Edmonton

Variety	Yield in bushels per acre		Difference in bushels per acre due to seed treatment
	Leytosan P	Control	
			%
Stratagem	32.04	23.11	7.93
Alderman	31.07	25.25	5.82
Horsford	35.76	31.56	4.20
Tall Telephone	28.53	24.85	3.68
Daisy	27.44	24.07	3.37
American Wonder	30.13	27.53	2.60
Surprise	17.67	15.55	2.12
Perfection	36.80	34.94	1.86
Lincoln	32.01	30.46	1.55
Laxton's Progress	19.21	18.08	1.13
Thomas Laxton	18.75	17.88	0.87
Laxton Superb	21.69	21.09	0.60
Little Marvel	21.60	21.07	0.53
Advancer	27.44	27.07	-0.03
Alaska	20.88	21.50	-0.62
Golden Vine	34.26	34.92	-0.66
Hundredfold	17.31	17.98	-0.67

To be significant the difference must exceed bushels.

These experiments have demonstrated varietal response to seed treatment. This relative response, however, may be influenced by moisture, temperature, soil flora and other factors. These factors may be responsible for the lack of relationship between some of the varieties in the Brooks and Edmonton trials. Wallace and Henry (10) have demonstrated a marked difference in germinations and rate of germination of different varieties at different temperatures. As the varieties in each of these experiments were grown under the same conditions of temperature and

moisture, these naturally were not optimum for all varieties, as the longer the seed takes to germinate the greater the damage from soil-borne organisms and the less possibility for emergence. Hence these relationships might not hold for another set of conditions.

Large Scale Field Trials with Leytosan P at Brooks

Field tests were conducted on a large scale at Brooks in three of the contract fields of peas for the Grimm Alfalfa Seed Growers Limited. The varieties used were Stratagem, Thomas Laxton and Laxton Progress. The seed was treated with Leytosan P at the rate of 2 ounces per bushel one week prior to seeding, and sown with the grain drill in the same manner as the other fields were sown. The peas here were sown at the rate of 120 pounds per acre in double rows 28 inches apart, the double rows being 6 inches apart.

Emergence counts were made 30 days after planting. Counts were made on nine feet of double row, selected at random. The figures in Table VIII show the average of 50 such counts. The difference is expressed as percent of the control.

These figures indicate a marked benefit from the seed treatment in the increased population. Under field conditions Stratagem shows a greater benefit from seed treatment than either Thomas Laxton or Laxton Progress.

TABLE VIII

Effect of Leytosan P on emergence in large scale field trials

Variety	Leytosan P	Control	Difference in %
Stratagem	56	28	100
Laxton Progress	61	46	32.6
Thomas Laxton	97	80	21.3

RELATIVE RESPONSES OF PEA VARIETIES TO SEED TREATMENT IN THE GREENHOUSE

Effect of Leytosan P on Emergence of Four Varieties of Peas

The first greenhouse experiment was conducted to determine the effect of Leytosan P, a proprietary dust, on the emergence of different varieties of peas. Four varieties were selected, two early varieties, Alaska and Thomas Laxton, and two late varieties, Horsford and Tall Telephone.

Experimental Method.

Three hundred and sixty seeds of each variety were sown, one-half being treated with Leytosan P at the recommended rate of 2 ounces per bushel. The seed was placed in a glass stoppered flask and the mercury dust

added and thoroughly shaken up. The seed was treated 48 hours prior to seeding. The other 180 seeds were sown as a control. The seeds were planted in two parts Edmonton soil, a heavy black loam, with one part sand, in crocks 12 inches deep by 8 inches in diameter, 10 seeds per crock making 36 crocks of each variety, 144 in all. The seed was covered to a depth of 1½ inches, and the soil watered by means of placing the crocks in water pans until the surface of the soil appeared moist. All crocks received the same amount of moisture as closely as could be determined, and were kept in the greenhouse where the temperature was maintained at 65°F. with the soil approximately 12°C. All varieties were randomized and the crocks moved three times on the greenhouse bench to reduce the error as much as possible.

Experimental Results.

Emergence counts were made, and are presented in Table IX with a complete analysis of variance to determine their significance in Table X.

TABLE IX

Effect of Leytosan P on the emergence of four varieties of peas

Treatment	Average emergence in %			
	Alaska	Horsford	Thomas Laxton	Tall Telephone
Leytosan	97.7	82.8	95.5	93.8
Control	91.7	74.4	86.6	72.2
Variation	6.0	8.4	8.9	21.6

S.D. = 7.5%. To be significant the difference between the variety means of the seed treatments must exceed $2\sqrt{2}$ x S.E. = 5.0%.

TABLE X

Complete analysis of variance for emergence from treated and non-treated seed

Source of variation	Degree of freedom	Sum of squares	Mean of squares	F	5% pt.	1% pt.
Varieties	3	58.4	19.5	34.82	2.68	3.94
Treatments	1	45.5	45.5	81.25	3.92	6.84
Replicates	17	24.1	1.4	2.50	1.83	2.33
Error	122	68.0	0.56			
Total	143	196.0				

Jones (14, 15) found that the sweet wrinkled varieties responded to treatment with a mercury dust more so than did Alaska, a smooth-seeded variety. He found Horsford Market Garden to be resistant to Ascochyta foot-rot, which variety the author has also observed to show relatively light injury from any form of seed or foot-rot in the pea fields at Brooks. Tall Telephone, however, was observed to suffer considerable reduction in emergence number and many seedlings after emergence in the field failed to reach maturity.

It will be observed from Table IX that there is a significant difference in emergence in all cases, but in an ascending order from Alaska which is baraly significant to Tall Telephone which shows a marked increase in emergence of seedlings from treated seed over that of the non-treated.

A noticeable feature in the experiment was the fact that in Alaska and Thomas Laxton the treated seed

germinated much more rapidly than the non-treated; this was the case in the Tall Telephone, but not to the same extent as in the Alaska and Thomas Laxton. The Horsford Market Garden showed little difference.

The inference which might be drawn from this experiment is that the mercurial dust had a tonic effect on the seed resulting in increased emergence and rate of emergence from the treating of the seed (12).

In this experiment if the rate of emergence can be accepted as an indication of stimulation, then the Alaska variety responds to the tonic effect of the methyl mercury phosphate. Figure 5 shows graphically the increased rate of emergence of the treated seed over the non-treated seed. Here the total emergence of both treated and controls show little difference at the end of 5 days, but at the end of the third day the treated shows a much increased emergence over the control. As both lots were relatively free from disease, the increased rate of germination or emergence can be attributed to the treatment.

Similar results were obtained by Horsfall et al (12) in treating Perfection peas with red copper oxide.

The accelerated emergence of the Alaska peas may be the result of a bichemical effect. The chemical may be broken down liberating the phosphate which, as is generally known, accelerates germination growth and yield. The amount of phosphate present, however, would not seem to be of sufficient quantity to have any great stimulating effect.

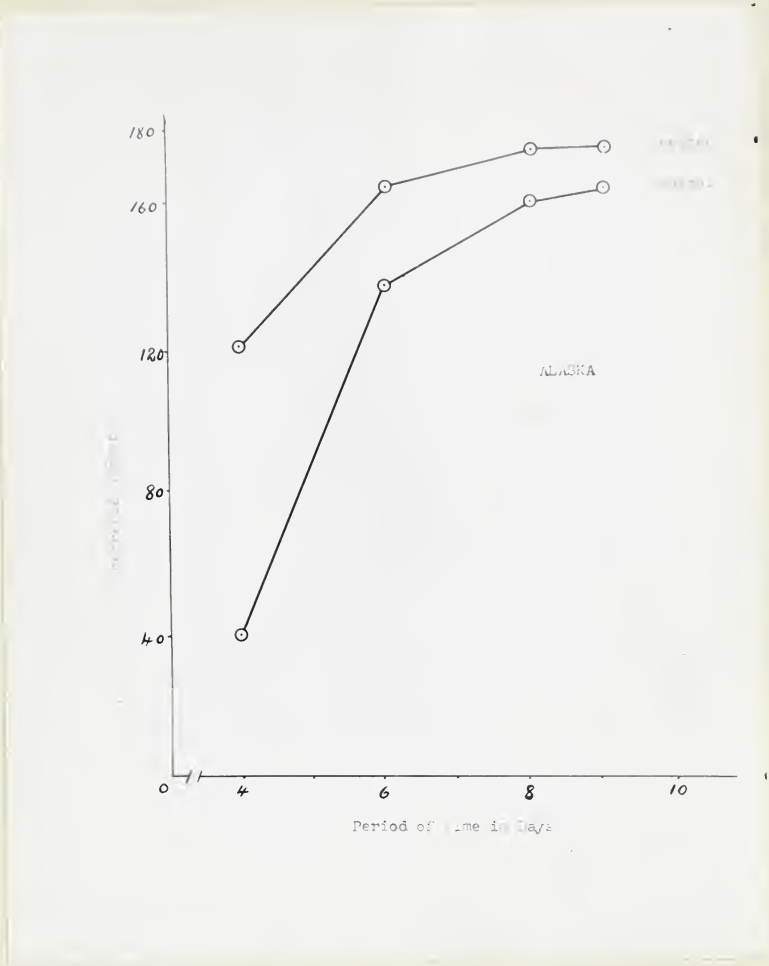

Figure 5

Emergence rate of seedlings from treated and non-treated Alaska seed in Edmonton soil.

Lundegardh (17) has shown where mercury in certain quantities has a stimulating effect on germination on certain varieties. Probably it might be the action of the mercury rather than the phosphate. This possible stimulating effect was not apparent in the other varieties due to the greater amount of disease present in the control to which the reduced rate of germination could be attributed.

Effect of Leytosan P on Emergence of Eight Varieties of Peas

A second experiment was conducted with a larger number of varieties to determine if the variations manifest in the varieties used in the first experiment would be evident in those selected for this trial.

Experimental Method.

Four additional varieties were selected and 140 seeds of each sown, 10 seeds per pot, in pots 7 inches in diameter; 70 seeds treated with Leytosan P in a similar manner to that used in the first experiment and 70 seeds used as a control. The seeds were sown and covered to a depth of 1½ inches. Moisture was added as in the first experiment, and the greenhouse maintained at a constant temperature of 65°F. All treatments and varieties were randomized.

Experimental Results.

Emergence counts were made and are presented in Table XI. Table XII gives a complete analysis of variance for these data.

TABLE XI

The effect of seed treatment with Leytosan P on emergence of eight varieties

Treatment	Average emergence in %							
	Horsford	Laxton Progress	Alaska	Thomas Laxton	Tall Telephone	Stratagem	Surprise	Little Marvel
Leytosan	85.7	87.1	95.7	100.0	90.0	87.1	98.5	87.1
Control	64.3	57.5	55.7	44.3	30.0	24.3	32.8	20.0
Difference	21.4	29.6	40.0	55.7	60.0	62.8	65.7	67.1

S.D. = 13.1%.

To be significant the differences between variety means must exceed $2\sqrt{2}$ x S.E. = 14%.

TABLE XII

A complete analysis of variance for the data of Table XI

Source of variation	Degree of freedom	Sum of squares	Mean of squares	F	5% pt.	1% pt.
Varieties	7	75.5	10.8	6.28	2.03	2.69
Treatments	1	715.1	715.1	415.75	3.94	6.90
Replicates	6	37.7	6.3	3.66	2.19	2.99
Remainder	97	167.2	1.7			
Total	111	995.2				

The results here again indicate a beneficial effect and a difference in response of varieties to the use of Leytosan P as a fungicide. In all cases there is a significant difference between the controls and the treated seed. Horsford Market Garden shows the least response to treatment, giving the greatest germination from the non-treated seed and the least germination from the treated seed. The experiment demonstrates a gradual increase in response from Horsford in an ascending order to Little Marvel.

Effect of Seed Treatment on Plant Growth

To demonstrate a possible effect on growth as well as emergence as a result of seed treatment it was thought advisable to follow the plant growth through to maturity, to note the effect, if any, of seed treatment on growth, and blossoming to determine if the varietal difference noted in emergence continued throughout the life of the plant.

Four varieties were selected, Thomas Laxton, Horsford Market Garden, Alaska and Tall Telephone, the varieties used in the first experiment for emergence determination.

Experimental Method.

Three hundred and sixty seeds were planted, 10 seeds per crock. One hundred and eighty seeds were treated with Leytosan P at the rate of 2 ounces per bushel, the seeds were placed in a glass stoppered flask and shaken up thoroughly with the Leytosan 48 hours prior to planting. Crocks, 12 inches deep with 8-inch diameter, with glazed outer surface to prevent evaporation, were filled with a mixture of 2 parts Edmonton black loam and 1 part sand. The seed was covered to a depth of 1½ inches and water absorbed from the watering pans through the opening in the base of the crock until the surface appeared moist. The greenhouse temperature was maintained at approximately 65°F. throughout the growing period, and artificial light was supplied for a 7-hour period from 5.00 p.m. to 12.00 p.m. each evening.

When emergence was complete the plants were thinned out, leaving two plants per crock. The growth was measured and recorded; these measurements were made until growth appeared to be complete. It was originally intended to carry this experiment through to maturity of the plants to determine yield, but the greenhouse conditions were not conducive to blossoming.

Experimental Results.

Table XIII presents a record of measurements made, expressed as the average growth in inches of the treated and non-treated plants for each variety.

TABLE XIII

Growth of pea varieties

Interval of measurement in days

Variety	Treatment	Growth in inches											
Days -		0	2	2	3	3	8	8	10	10	10	5	5
Alaska	Leytosan P	3.0	5.1	6.9	9.0	10.8	15.8	20.3	21.9				
	Control	2.6	4.5	6.3	8.4	9.3	14.0	17.7	19.3				
Thomas Laxton	Leytosan P	3.3	5.5	7.3	9.5	12.5	18.6	23.9	31.2	32.5			
	Control	2.9	4.3	6.0	7.4	9.8	13.8	17.7	23.3	24.3			
Tall Telephone	Leytosan P	3.0	5.1	7.2	9.3	13.6	20.2	25.7	33.7	49.8	58.0	60.0	
	Control	2.4	4.1	5.9	7.3	9.2	14.4	19.0	25.7	38.4	44.5	46.0	
Horsford Market Garden	Leytosan P	2.3	3.2	3.9	4.5	5.6	7.5	9.7	13.5	18.8	24.9	28.3	30.1
	Control	2.1	3.0	3.5	4.1	5.1	7.3	8.5	12.7	17.7	23.4	26.8	29.1

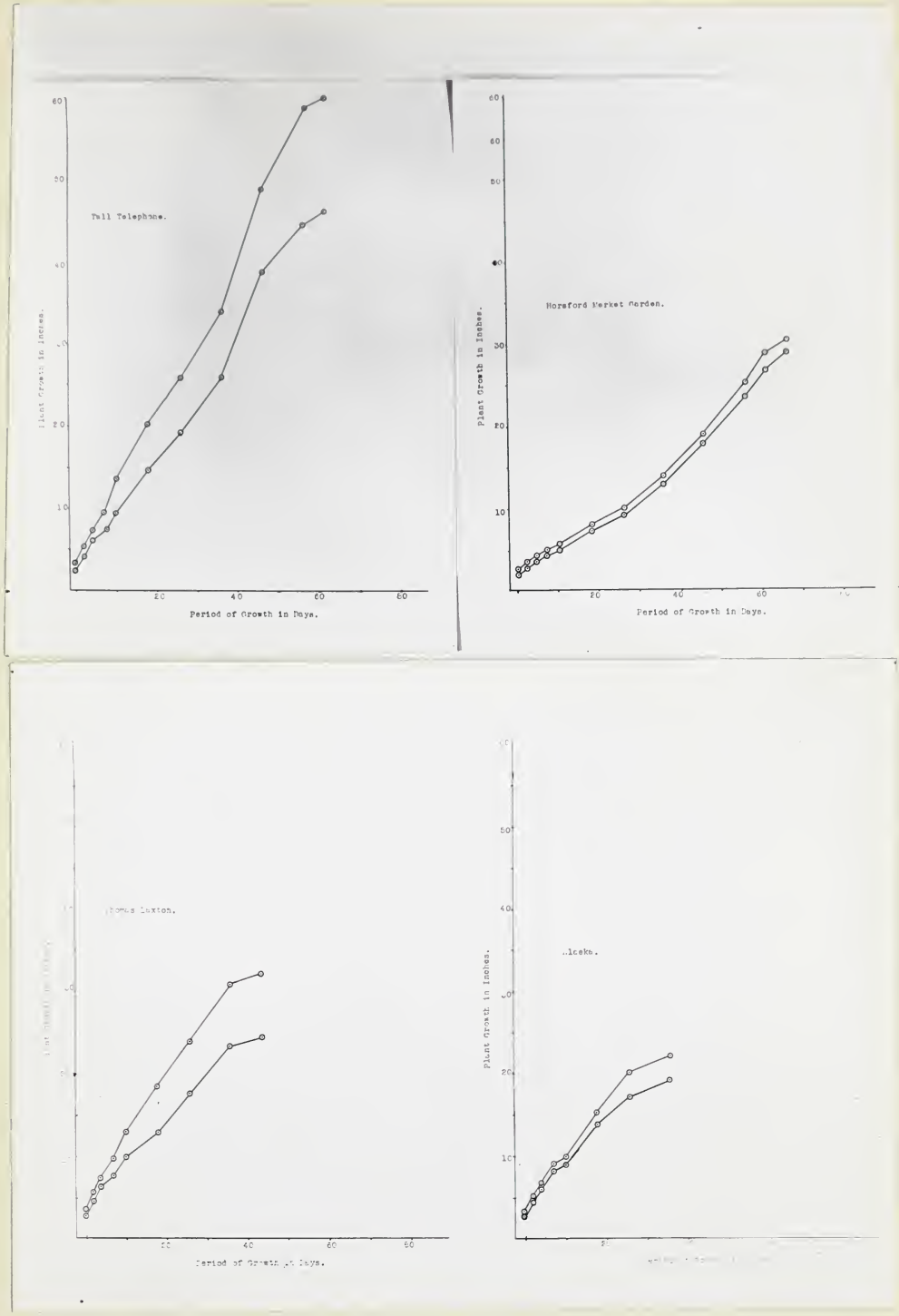

Figure 6

Plant growth from treated and non-treated seed. The top line represents growth from the treated seed.

From the results of this experiment (Figure 6 and Table XIII) and observations not recorded, facts observed by the author, the plants from the treated seed as a whole made a better growth than the control plants. The Tall Telephone variety showed a greater response to treatment as shown in the graph than any of the others: Thomas Laxton, Alaska, then Horsford. The Tall Telephone control plants showed a greater number of plants stunted, dwarfed and killed as a result of parasitism by the seed- and foot-rotting organisms present, than did any of the others. A number of the control plants were equally as good and some better than the plants from the treated seed, however. Tall Telephone shows the greatest increase and Horsford the least. In the case of the Horsford variety there appeared to be relatively little difference. The control plants did not suffer from the ravages of the foot-rotting organism to the extent of the Telephone variety and appeared in most cases to make equally as good growth as the treated lot. Alaska showed a greater response than did the Horsford, but not to the extent of the other varieties.

A marked difference was noted in the increased number of plants with three blossoms in the Thomas Laxton treated over the control although both lots started to blossom at the same time. In the case of the Alaska, although both lots started blossoming at the same time there were no cases of plants with three blossoms in the control.

Although conditions were apparently not conducive to blossoming in the greenhouse, the mercury dust comparatively did favour the increased number of blossoms. The experiment shows a more marked benefit of treated seed over non-treated in the following order: Tall Telephone, Thomas Laxton, Alaska and Horsford. This benefit, however, cannot be accepted as evidence of plant stimulation because some of the plants from non-treated seed were equally as strong and vigorous as the treated plants, in many instances the check plants were better than many of the treated, but in the control lots there were a number of weak, sickly plants that were not present in the treated lots. The greater number of weak plants in the Tall Telephone over the other varieties is evidence of the greater susceptibility of Tall Telephone to the seed- and foot-rotting organisms, and for this reason the increased average growth of the plants from treated seed over the control should not be interpreted as stimulation of growth due to seed treatment.

Greenhouse Tests for a Comparison of Leytosan P and New Improved Ceresan

As a result of tests with Leytosan P and New Improved Ceresan in the trial plots at Brooks where indications were recorded showing New Improved Ceresan to be more effective for treatment of some varieties of peas and

Leytosan P for others, tests were conducted in the greenhouse at Edmonton to check these results.

Experimental Method.

Five replicates of each treatment, control, New Improved Ceresan and Leytosan P, including eight varieties, namely, Perfection, Horsford, Alaska, Little Marvel, Thomas Laxton, Tall Telephone, Surprise and Stratagem, were planted in a similar manner to the last two experiments. Leytosan was added at the rate of 2 ounces per bushel and New Improved Ceresan at the rate of ½ ounce per bushel, the seed being shaken up with the dust in a glass stoppered flask 48 hours prior to seeding. The seed was covered to a depth of 1½ inches and water added in a light spray. The second day the pots were given a heavy application of water. The soil used in this experiment had been used for emergence tests of a previous experiment but was thoroughly screened over a fine mesh screen before being used. Emergence counts were made every day after the first plants appeared.

Experimental Results.

Table XIV presents the emergence counts, and a complete analysis of variance is given in Table XV.

TABLE XIV

Relative responses to Leytosan P and New Improved Ceresan of eight varieties of peas

Variety	Average emergence in %			Difference in		
	Leytosan P	New Improved Ceresan	Control	Leytosan P and control in %	New Improved Ceresan and control in %	New Improved Ceresan and Leytosan P in %
Perfection	56.0	52.0	72.0	-16.0	-20.0	4.0
Thomas Laxton	78.0	82.0	66.0	12.0	16.0	-4.0
Alaska	60.0	80.0	48.0	12.0	32.0	-20.0
Little Marvel	60.0	76.0	30.0	30.0	46.0	-16.0
Horsford	70.0	76.0	34.0	36.0	42.0	-6.0
Tall Telephone	62.0	72.0	22.0	40.0	50.0	-10.0
Surprise	62.0	60.0	36.0	26.0	24.0	2.0
Stratagem	76.0	74.0	10.0	66.0	64.0	2.0

S.D. = 4%.

To be significant the differences of the variety means must exceed $2\sqrt{2}$ x S.E. = 5.10%.

TABLE XV

A complete analysis of the emergence data of Table XIV

Source of variation	Degree of freedom	Sum of squares	Mean of squares	F	5% pt.	1% pt.
Treatments	2	268.8	134.4	35.4	3.09	4.82
Varieties	7	81.0	11.6	3.1	2.19	2.99
Replicates	4	43.0	10.8	2.8	2.46	3.51
Error	106	401.0	3.8			
Total	119	793.8				

These results indicate the value of Leytosan P to be the greatest for Stratagem and decreasing in value for the other varieties in the following order: Surprise, Tall Telephone, Horsford, Little Marvel, Alaska, Thomas Laxton and Perfection. The varieties responded in a different order to New Improved Ceresan as follows: Stratagem, Tall Telephone, Little Marvel, Surprise, Horsford, Alaska, Thomas Laxton and Perfection.

With the exception of Perfection which shows a significant decrease in emergence from the treated seed, all other varieties exhibit a significant increase in emergence number.

Many of the seedlings died shortly after emergence and a number appeared sickly, a fact which may be attributed to the use of the soil from previous pea emergence tests in which soil the number of seed- and foot-rotting organisms had undoubtedly increased greatly in number as a result of contamination from previously rotted seeds. The heavy application of water the second day after planting probably had some effect on delaying emergence (15) resulting in a greater number of seeds being rotted. For Alaska, Little Marvel, Tall Telephone and Horsford, New Improved Ceresan gives a significant increase in emergence number over Leytosan P, and also gives a slight increase in the Thomas Laxton. The Leytosan P proved superior for Perfection, Surprise and Stratagem, although not significantly so in this test.

This experiment has not shown the varieties included to respond in the same order as that found in field and previous greenhouse tests, which fact further emphasizes the possibility of a variety responding to different treatments in different ways under the various combinations of moisture, temperature, soil and other possible factors.

Effect of Seed Treatment with Leytosan P on Emergence in Sterilized Soil

The two previous experiments demonstrate a varietal response to treatment with Leytosan P and indicate a stimulating effect from this proprietary dust. To determine whether or not it was actual stimulation or merely an increased emergence and rate of emergence due to control of the parasitic fungi, an experiment was conducted using sterilized soil. This experiment was identical in all respects to the last with the exception that sterilized soil was used. Unfortunately the sterilized soil would not absorb the water from the pans and the soil had to be watered from the surface.

Experimental Results.

Emergence counts were made and are presented in Table XVI and a complete analysis of variance in Table XVII.

TABLE XVI

Emergence counts of seedlings from seed treated with Leytosan P in sterilized soil

Treatment	Average in %							
	Horsford	Laxton Progress	Thomas Laxton	Surprise	Tall Telephone	Alaska	Stratagem	Little Marvel
Leytosan	77.1	85.7	87.1	90.0	94.3	93.1	90.0	93.1
Control	91.4	93.1	93.1	94.3	97.1	93.1	87.1	85.7
Variation	-14.3	-7.4	-6.0	-4.3	-2.8	0.0	2.9	7.4

S.D. = 9.4%.

To be significant, the difference between the variety means must exceed $2\sqrt{2}$ x S.E. = 10%.

TABLE XVII

A complete analysis of variance of the data in Table XVI

Source of variation	Degree of freedom	Sum of squares	Mean of squares	Variance	5% pt.	1% pt.
Varieties	7	11.25	1.61	1.81	2.03	2.69
Treatments	1	2.56	2.56	2.97	3.94	6.90
Replicates	6	10.58	1.76	1.97	2.19	2.99
Remainder	97	86.51	0.89			
Total	111	110.90				

All varieties, with the exception of three, gave a decreased germination as a result of treatment with Leytosan P. Alaska showed no difference, while Stratagem and Little Marvel exhibited an increase that might be

interpreted as a direct chemical stimulus to the seed, but the differences here are not significant.

This experiment demonstrates that if there is any stimulating effect in the two varieties, Stratagem and Little Marvel, from Leytosan P, this tonic effect is not significant. Rather does it show a detrimental effect on seed when there is no disease factor present. Horsford Market Garden evidences a significant detrimental effect as a result of treatment with the dust under controlled conditions of sterilized media, which is not surprising because of the relative small response under normal conditions.

This lack of evidence of stimulation here may be attributable to the fact that the sterilized soil lacks the microflora necessary to liberate the phosphate from the compound. Here there was no bichemical action, and the mercurial dust probably remained constant for a longer period of time. It is possible that in the dust form it may exert an injurious effect on the seed, as indicated in this experiment. The variation in varieties may be an indication of their resistance to injury from the Hg ion (17).

THE EFFECT OF LEYTOSAN P ON THE DEGREE OF SEED ROTTING OF TEN VARIETIES OF PEAS

Infection Rating at 15 Days

Emergence counts did not give a complete picture of the situation, although they do give in a general way the order of response of varieties to such treatment. They do not, however, give the degree of damage to the seed, or in other words, the susceptibility of the varieties to attack from soil-borne organisms. In some varieties, although emergence counts might be high, the seedlings emerging might not survive due to the rotting of the seed induced by soil-borne organisms. The seed may be rotted although emergence was accomplished.

An experiment was conducted to determine an infection rating for a number of varieties of peas. Ten varieties were selected, Daisy and a marrowfat variety, Jap Sweet Wrinkled, being included.

Experimental Method.

There were nine replicates of each (control and treated) variety and five replicates of each variety in sterilized soil as a further check. The seed was dusted at the rate of 2 ounces per bushel in a similar manner to that used in previous experiments. Fifty seeds per pot

were planted, 1 inch deep. All pots were given a maximum amount of moisture and the temperature of the greenhouse maintained at 68°F., (a high temperature and high moisture content are conducive to increased disease of the seed (2, 14)) and soil from 10° to 18°C.

After 15 days the seeds were removed from the soil and examined, and the seeds scored from 1 to 5, 1 being entirely free from rot and 5 being completely rotted.

Experimental Results.

The results of this experiment are presented in Table XVIII with a complete analysis of variance in Table XIX.

TABLE XVIII

Degree of damage to pea seed treated with Leytosan P and non-treated pea seed as control in soil

Treatment	Infection rating									
	Daisy	Horsford	Alaska	Laxton Progress	Surprise	Stratagem	Thomas Laxton	Tall Telephone	J.S.W.	Little Marvel
Control	4.31	1.88	1.97	2.90	4.03	3.83	4.03	4.21	4.51	4.50
Leytosan	3.69	1.21	1.20	1.26	1.55	1.31	1.11	1.00	1.22	1.14
Variation	0.62	0.67	0.77	1.64	2.48	2.52	2.92	3.21	3.29	3.36

S.D. = 0.61.

To be significant the difference between variety means must exceed $2\sqrt{2}$ x S.E. = 0.58.

TABLE XIX

Complete analysis of variance for Table XVIII

Source of variation	Degree of freedom	Sum of squares	Mean of squares	F	5% pt.	1% pt.
Varieties	9	81.17	9.02	24.37	2.00	2.63
Treatments	1	207.59	207.59	561.05	3.90	6.81
Replicates	8	0.18	0.022	0.06	2.93	4.86
Error	161	59.57	0.370			
Total	179	348.61				

In this experiment an accompanying check was included in which treated and non-treated seed was sown in sterilized soil. At the end of the 15-day period all varieties with the exception of Daisy showed complete freedom from any form of rot in the treated and non-treated seed. (The) Daisy showed a high percent of seed-rot in both treated and non-treated seed. This would indicate that (the) Daisy harbored an internally-borne parasite or parasites that are not controlled by the Leytosan P.

These data show the difference in infection rating between treated and non-treated seed in an ascending order from Horsford to Little Marvel, with the difference significant in all cases but to the greatest extent in Little Marvel and the least in Horsford. Daisy will not be taken into consideration because of the apparently seed-borne organisms which were not controlled by Leytosan P.

Infection Rating at 10 Days

In the previous experiment the rotting in some of the varieties had reached a well advanced stage. It was thought that examination of the seed at an earlier stage might give a greater difference between varieties, that is, would make varietal differences probably more striking. Consequently this experiment was repeated with all varieties and the infection rating determined at 10 days after planting. The temperature and moisture were kept as close to that of the previous experiment as was possible.

Experimental Results.

The results of this experiment are presented in Table XX with a complete analysis of variance in Table XXI.

TABLE XX

Degree of rotting of pea seed treated with Leytosan P and control in soil for 10-day period

Treatment	Infection rating									
	Horsford	Daisy	Thomas Laxton	Alaska	Laxton Progress	Little Marvel	Surprise	J.S.W.	Stratagem	Tall Telephone
Control	1.97	4.90	2.71	3.21	3.72	3.68	3.44	3.56	4.63	3.80
Leytosan	1.63	3.90	1.53	1.88	2.20	1.85	1.55	1.39	2.32	1.49
Variation	0.34	1.00	1.18	1.33	1.52	1.83	1.89	2.17	2.31	2.31

S.D. = 0.51. To be significant the difference between variety means must exceed $2\sqrt{2}$ x S.E. = 0.478.

TABLE XXI

Complete analysis of variance for Table XX

Source of variation	Degree of freedom	Sum of squares	Mean of squares	F	5% pt.	1% pt.
Varieties	9	92.91	10.32	37.16	2.00	2.63
Treatments	1	110.12	110.12	400.04	3.90	6.81
Replicates	8	8.26	1.03	3.71	2.00	2.63
Remainder	161	44.41	0.275			
Total	179	255.70				

With the exception of Horsford Market Garden there is a significant difference between the treated and non-treated seed of all varieties, and between a number of varieties themselves. The order of varieties here shows a somewhat different sequence to that of the last experiment.

This would appear to be due to the rate of action of the organisms present on the seed. Thomas Laxton and Little Marvel show comparatively less decomposition in the early stages than they show at the 15-day period.

These experiments indicate a variation in rate of rotting among the varieties, which may be interpreted as further indication of susceptibility of the varieties to the seed-rot organisms present.

The rate of germination and emergence in these two trials was reduced considerably, probably due to the increased amount of water added to the soil. The comparative rate of the germination of the treated and non-treated

seed was noted, however, and found to be greater for the treated seed, evidence in support of the theory of stimulation due to treatment. For this information the germination rate of the treated seed was compared with the germination rate of only viable seeds of the control that appeared to be free from disease.

In general it may be stated that the results of these two experiments are similar to those from the emergence experiments. That is, that Horsford and Alaska show relatively little response to the seed treatment, while Little Marvel, Tall Telephone and Stratagem exhibit considerable benefit, with other varieties intermediate in response, no one variety holding any constant position, probably due to the effect of moisture, temperature and other factors.

THE SIGNIFICANCE OF INTERNAL SEED-BORNE ORGANISMS

Experimental Method.

In order to determine the possible significance of internal seed-borne organisms, a number of varieties of peas was selected and 100 seeds of each were surface sterilized with Leytosan P for 48 hours, and 10 seeds were plated out in each of 10 potato dextrose agar plates. A second series of 100 seeds was surface sterilized with $HgCl_2$, mercury chloride, 1-1000, for 3 minutes and plated

out in a similar manner. A third series was surface sterilized with the mercuric chloride solution for 5 minutes and plated out.

Ten days after plating the seeds were all examined for the presence of disease, and a record made.

Experimental Results.

The following Table XXII shows the Daisy to be the only variety with internal seed-borne organisms present, or if present not controlled by Leytosan P or mercuric chloride.

TABLE XXII

Determination of internal seed-borne organisms

Variety	Leytosan P	$HgCl_2$ 3 min.	$HgCl_2$ 5 min.
Horsford	-	-	-
Alaska	-	-	-
Daisy	✓	✓	✓
Thomas Laxton	-	-	-
Little Marvel	-	-	-
Tall Telephone	-	-	-
Stratagem	-	-	-

✓ indicates presence of disease.
- indicates absence of disease.

The photograph of plates (Figure 7) shows the presence of seed-borne organisms on the Daisy seed on the $HgCl_2$ 5-minute treatment and Leytosan P respectively, while there is a marked absence on the Little Marvel variety in both $HgCl_2$ 5-minute and Leytosan P treatments.

Figure 7

The two upper plates, Little Marvel treated with Leytosan P and $HgCl_2$ for 5 minutes respectively. The two lower plates, Daisy treated with Leytosan P and $HgCl_2$ for 5 minutes respectively.

A number of organisms seemed to be present in the seeds of the variety Daisy. Two species of bacteria appeared consistently, "A" producing a whitish, smooth slimy colony, the other, "B", a roughened ridged, rubbery colony, turning dark brown in the later stages. A number of fungi were present including species of Penicillium, and the others producing a downy growth on the pea, varying in color from white to red, black, green and yellow. The bacterium species "B" appeared to produce the most rapid decomposition of the pea seed, reducing it to a cheesy texture readily cut with a knife blade.

This organism, bacterium species "B", was plated out on agar prepared from the seed extract of different varieties of peas and the rate of growth observed. There appeared to be no consistent differences in rate of growth on any of the extract media that was exhibited by Fusarium Martii and a Bacterium species reported elsewhere. Growth was very much more rapid on potato dextrose agar than was the case with the other Bacterium species isolated by Wallace.

This particular variety of peas, Daisy, has for the past three years given a consistently poor stand at Brooks. This has been attributed to drill damage, hard seeds, and soil infested with organisms causing various forms of seed- and foot-rots. Daisy is a dwarf variety and the large pods often touch the ground, becoming wet and sometimes their own weight forces the pod tips into the

soft earth while being irrigated. This may account for the infestation in part.

In the case of seed infested with internal-borne organisms, Leytosan P is ineffective as a form of seed treatment. No known form of surface sterilization would be effective in the control of the internal-borne organisms. A form of treatment similar to the hot water treatment for smut would probably be the only form of successful control, which treatment would not be desirable for peas.

A laboratory test of suspicious samples would be of considerable value in determining the presence of internal-borne organisms to ascertain the probable performance of the seed and the economic value of treatment with any surface disinfectant or seed protectant.

THE EFFECT OF SEED EXTRACTS OF DIFFERENT VARIETIES ON THE GROWTH OF TWO SEED-ROTTING ORGANISMS

Experimental Method.

Two organisms isolated by H. Wallace from rotted pea seed grown in Edmonton soil, one identified as Fusarium Martii and one a Bacterium species, were found to be capable of rotting seeds of all varieties of peas grown here.

As a result of the apparent greater susceptibility of some varieties to disease produced by these organisms an experiment was made to observe their growth on agar prepared from seed extract of various pea varieties.

Seeds of different varieties of peas were ground in a Wiley mill and equal quantities added to agar. The agar was strained a number of times through cheesecloth to clear it, and equal quantities were added to petri dishes. The organism was added to the centre of each plate, and the rate of growth was determined by recording the increase of the diameter of the colonies in mm.

Experimental Results.

The rate of growth of the Fusarium Martii is shown in Table XXIII. As the growth was so close for a number of varieties it was difficult to show graphically, so the growth of only four varieties is shown in Figure 8. Here it will be seen the rate of growth is much more rapid for Tall Telephone, intermediate for Thomas Laxton and considerably slower for Alaska and Horsford, which is in accordance with the effect of Leytosan P on emergence of these varieties, Horsford and Alaska showing the least difference in treatment and control and Tall Telephone and Thomas Laxton showing the greater difference. An interesting feature noticed was that Fusarium Martii growing on Tall Telephone extract showed a decided red pigmentation at an early date, on other pea extract media, Fusarium Martii

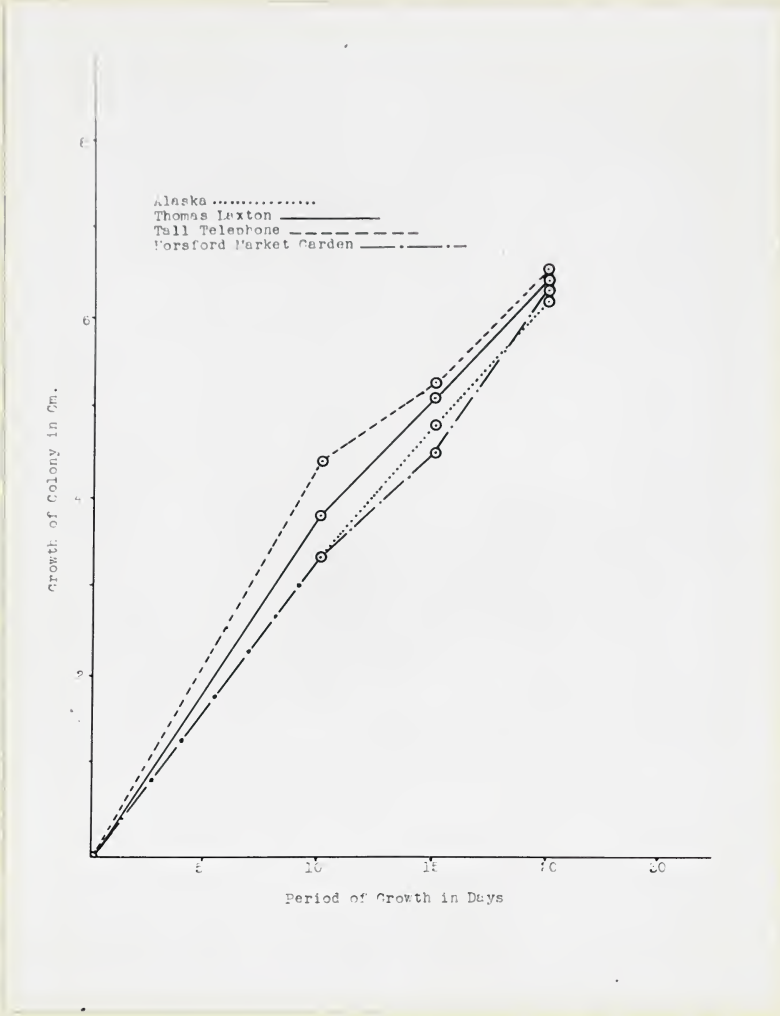

Figure 8

Effect of seed extract from the four pea varieties indicated on the rate of growth of Fusarium Martii on agar.

developed varying degrees of redness. Colonies on the Surprise extract agar showed no indication of pigmentation at any stage, while colonies on Stratagem extract agar developed a dull red over the entire plate at a later date.

TABLE XXIII

The effect of seed extracts of different varieties of peas on the growth of Fusarium Martii

Variety	Growth in cm.			
Interval of measurement in days.	0-10	15	20	25
Tall Telephone	4.4	5.3	6.65	7.50
Little Marvel	4.2	5.2	6.70	7.60
Laxton Progress	4.2	5.1	6.27	7.30
Thomas Laxton	3.8	5.1	6.50	7.65
J.S. Wrinkled	3.65	4.8	6.30	7.70
Stratagem	3.62	4.8	6.45	7.60
Alaska	3.32	4.8	6.40	7.30
Horsford	3.32	4.5	6.55	7.50
Surprise	3.32	4.5	6.20	7.70

The rate of growth of the Bacterium sp. was measured in a similar manner to the Fusarium Martii and is recorded in Table XXIV and the growth of four varieties represented graphically in Figure 9.

Here the rate of growth was reversed, the more rapid growth taking place on the Alaska and Horsford agar while the more slow growth took place on the Tall Telephone and Little Marvel agar with intermediate rates on the other varieties.

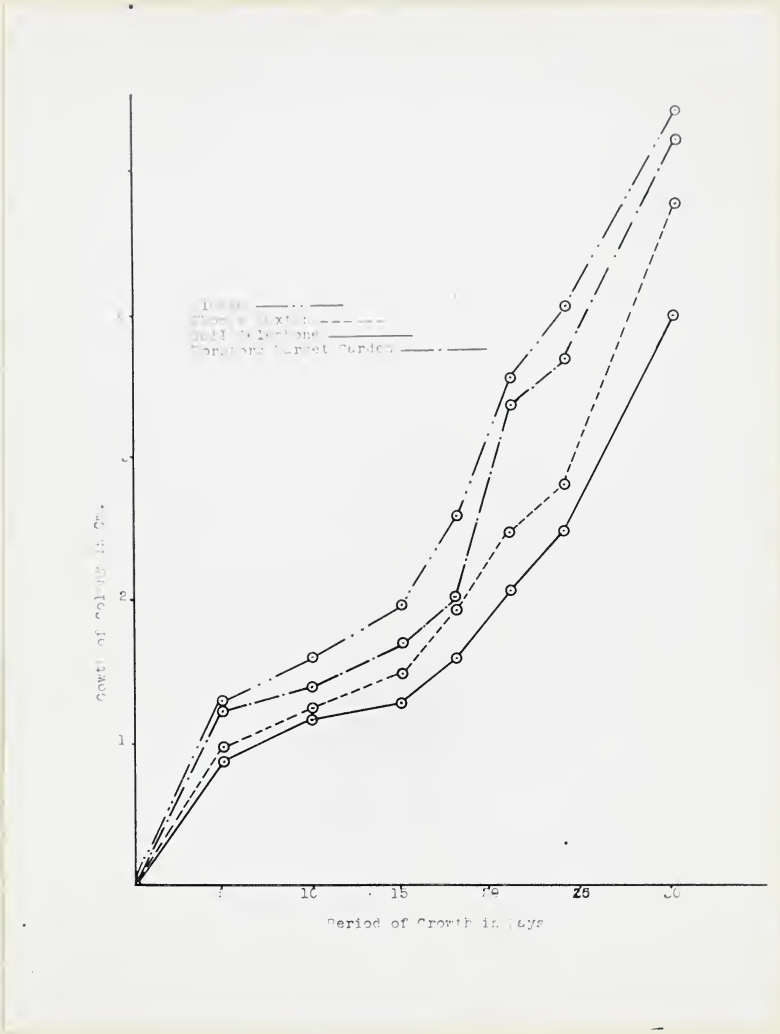

Figure 9

Growth of bacteria colonies on pea variety agar.

TABLE XXIV

The effect of seed extract from pea varieties on the growth of a Bacterium species

Variety	Growth in mm.						
Interval of measurement in days.	0-5	10	15	18	21	24	30
Alaska	1.32	1.675	2.0	2.63	3.6	4.1	5.4
Horsford	1.3	1.4	1.67	1.93	3.4	3.7	5.0
Surprise	1.0	1.3	1.6	2.10	3.5	3.8	5.2
Thomas Laxton	1.0	1.27	1.5	1.90	2.5	2.8	4.8
Laxton Progress	0.95	1.25	1.5	1.90	3.0	3.4	4.8
Stratagem	0.95	1.2	1.4	1.60	2.1	2.7	
Tall Telephone	0.9	1.2	1.3	1.60	2.1	2.5	4.0
Jap Sweet Wrinkled	0.87	1.2	1.6	1.90	3.1	3.5	
Little Marvel	0.8	1.0	1.3	1.60	2.5	2.86	4.2

The rate of growth on all the agars of this Bacterium sp. was relatively slow compared to the rapidity of the rotting of the seed caused by this organism. However, there may be a correlation between the relative rate on varietal agar and rotting of the seed due to this organism, or susceptibility of the variety. Unfortunately, experiments on this will not be complete to include in this publication.

DISCUSSION

Evidence accumulated in these experiments demonstrates a varietal difference in response of peas to seed treatment with Leytosan P.

Varietal difference in response to treatment varied in extent within experiments and to a greater extent in field experiments in different localities. This would indicate that soil and climatic conditions and soil flora were of importance in this respect (14, 25). The optimum conditions for germination and growth vary for different varieties (10) to a considerable extent. When these conditions are not optimum germination is delayed, and as a result the seed is more susceptible to the attack of seed- and foot-rotting organisms.

Table XXV lists the varieties in order of their response to seed treatment with Leytosan P in the experiments completed. Response to treatment has been determined by the difference in the figure for the treated seed and that for the non-treated.

In the field trials at both Edmonton and Brooks, Daisy and Stratagem ranked high in response to treatment with Leytosan P. In general, Tall Telephone, Daisy and Stratagem consistently give a high response to seed treatment, while Alaska and Horsford exhibit relatively little response. Little Marvel gave little response in field trials at Brooks, intermediate response in field trials at Edmonton, while in greenhouse tests this variety in the majority of instances exhibited the greatest response. Lincoln, in field trials at both Brooks and Edmonton, did not respond to treatment, but rather exhibited a slight depression in emergence and yield at Brooks. In the greenhouse tests,

TABLE XXV

Varieties listed in order of response to seed treatment with Leytosan P in the experiments reviewed

Field trials				Greenhouse trials at University of Alberta			
At Brooks		At Edmonton		Plant growth	Emergence 4 varieties	Emergence 8 varieties	Emergence in sterilized soil
Emergence	Yield	Emergence	Yield				
T.Telephone	Daisy	Daisy	Stratagem	T.Telephone	T.Telephone	L.Marvel	L.Marvel
Stratagem	T.Telephone	Stratagem	Alderman				
Daisy	Stratagem	L.Progress	T.Telephone	T.Laxton	T.Laxton	Surprise	Stratagem
T.Laxton	L.Progress	Alderman	Daisy				
L.Progress	Hundredfold	Surprise	Surprise	Alaska	Alaska	Stratagem	Alaska
Surprise	T.Laxton	L.Marvel	Horsford				
Hundredfold	Perfection	Hundredfold	Am. Wonder	Horsford	Horsford	T.Telephone	L.Progress
Perfection	Surprise	T.Laxton	L.Progress				
Horsford	Horsford	T.Telephone	Perfection			T.Laxton	T.Telephone
L.Marvel	Alaska	Perfection	Lincoln				
Lincoln	L.Marvel	Am.Wonder	T.Laxton			Alaska	Surprise
Alaska	Lincoln	Alaska	L.Marvel				
		L.Superb	L.Superb			L.Progress	T.Laxton
		Horsford	Advancer				
		Lincoln	Alaska			Horsford	Horsford
		Advancer	Hundredfold				

TABLE XXV (Continued)

Greenhouse trials at University of Alberta		Varieties in order of their influence on growth of organisms	
Infection rating 10 days	Infection rating 15 days	Bacterium sp.	Fusarium Martii
Tall Telephone	Little Marvel	Alaska	Tall Telephone
Stratagem	Marrowfat	Horsford	Little Marvel
Marrowfat	Tall Telephone	Surprise	Laxton Progress
Surprise	Thomas Laxton	Thomas Laxton	Thomas Laxton
Little Marvel	Stratagem	Laxton Progress	Marrowfat
Laxton Progress	Surprise	Stratagem	Stratagem
Alaska	Laxton Progress	Tall Telephone	Alaska
Thomas Laxton	Alaska	Marrowfat	Horsford
Horsford	Horsford	Little Marvel	Surprise

Laxton Progress exhibited relatively little response to seed treatment, being in a class with Alaska and Horsford, while in field trials this variety showed considerable response. Surprise, Thomas Laxton, Marrowfat, Perfection and Hundredfold appeared to be intermediate in all tests showing considerable benefit from treatment in the majority of tests. From field trials at Edmonton, Alderman appears to give a high response to seed treatment, American Wonder intermediate, with Laxton Superb and Advancer in a class with Alaska, Horsford and Lincoln. However, the Advancer, Laxton Superb, American Wonder might respond differently under different conditions, a possibility which has not been determined.

The fact that different organisms vary in rate of growth on agar prepared with seed extracts from different varieties of peas, indicates that it may be possible that these organisms show a similar reaction to the pea seed. The composition of the seed may have considerable influence on the susceptibility to attack from soil-borne organisms. The experiment on the effect of seed extracts on growth of the two organisms Bacterium species and Fusarium Martii, indicated that some varieties favoured the growth of these organisms to a greater extent than others. The reason may be that the different varieties vary in seed composition. Henry and Wallace (10) have shown that varieties vary in protein as well as carbohydrate content, but these

determinations at the time of writing have not been completed for all varieties used in this work. The fact that such differences occur is of importance, however, in arriving at a conclusion as to which varieties are likely to suffer to the greater extent and which will give the greater response to seed treatment.

If the bacteria (9) attack the seed first, then if the injury to the seed is comparable to its rate of growth on agar the Alaska and Horsford varieties would be injured to the greater extent. However, if Fusarium sp. were also present and parasitised the seed following the bacteria (9) then, its degree of injury being comparable to its rate of growth on agar, the Tall Telephone and Little Marvel varieties would suffer to a greater extent than other varieties. Another factor to be considered in arriving at a conclusion is the temperature relations of the different organisms. The possibility that varieties may vary in their resistance to attack from the various organisms comparable to growth on agar may affect results. Temperature relations may be favourable for an organism to which one variety may be very susceptible but to which another variety may be quite resistant. A different temperature may be favourable to an organism, to which the first variety may be the more resistant.

This brings out the point that there is an interrelation of factors having a bearing on differences in varietal response to seed treatment. However, under the

conditions for the above experiments with the organisms that are present, peas show a difference in varietal response to Leytosan P as noted above.

Although there was evidence of stimulation influencing the rate of germination in the first greenhouse experiment, in which the rate of emergence in Alaska treated with Leytosan P exceeds the rate of emergence of apparently healthy seeds in the control, stimulation in light of a tonic effect was not established.

In general it may be stated that when conditions are favourable for a rapid germination, most varieties will germinate well and produce a satisfactory stand. However, if conditions are not entirely favourable for a rapid germination of the seed, there will be a marked reduction in the stand due to a rotting of the seed in the soil by various seed- and foot-rotting organisms. This injury is more severe in such varieties as Tall Telephone, Daisy, Stratagem, Alderman and less in varieties like Alaska and Horsford.

When germination was not normal and emergence delayed due to injury from seed-rot, although the injury might be very slight, the consequent reduced vigor seemed to predispose the plant to attack from foot- and root-rot organisms, wounds in the tissue making entrance easily accomplished by other parasites. Pythium sp. were usually found associated in the tissues of seedlings and plants dying following seed- and foot-rot injury.

If the seed is protected by treatment from the attack of seed-rotting organisms and the plant obtains a vigorous start, it is better able to resist attack from the many other parasitic fungi and bacteria in the soil.

In this work, Leytosan P has amply demonstrated its value as a seed protectant in the soil for most varieties used in these trials. Its economic use might be questioned for such varieties as Alaska, Horsford and Lincoln, but Tall Telephone, Stratagem and Daisy should not be sown without first treating with some form of mercury dust. The other varieties used in these trials exhibited varying degrees of response to seed treatment. New Improved Ceresan was also found to be very effective as a seed treatment. A noticeable feature was that some varieties such as Horsford, Alaska and Perfection exhibited a greater response to New Improved Ceresan than to Leytosan P, while varieties such as Tall Telephone and Daisy showed a greater response to Leytosan P.

The seed of Daisy variety was found to harbor internal-borne seed-rotting organisms which were not controlled by seed treatment with Leytosan P. This fact is of importance in determining a difference in varietal response to seed treatment, because when internal-borne organisms are present the variety in question naturally would not respond to treatment. The Daisy seed used in field trials at Brooks, free from internal parasites, showed a marked varietal response, while the seed used

in the greenhouse trials, which harbored internal-borne organisms, showed little response. The latter seed lot was produced in a different year, and therefore under different conditions than the former.

CONCLUSIONS

1. Peas exhibit a varietal response to seed treatment with Leytosan P, with variations due to temperature, moisture and locality.

2. Seed treatment with Leytosan P and New Improved Ceresan gave marked increases in plant population, plant growth and yield. Some varieties responded to a greater extent to New Improved Ceresan and others to Leytosan P.

3. Internally borne seed-rotting organisms found to be present in the Daisy variety were not controlled by Leytosan P. Hence this failed to respond to treatment in certain cases, where the seed was internally infested.

4. Two organisms, Fusarium Martii and Bacterium sp. exhibited a variation in rate of growth when grown on media prepared with pea seed extract of different varieties. The rate of growth of the Bacterium sp. on pea seed extract agar holds an almost reverse order to that of the Fusarium Martii.

5. There was some evidence of stimulation in the germination of Alaska pea seed, as a result of the use of Leytosan P as a seed treatment.

6. No evidence of stimulation was observed in plant growth which could be attributed to a direct tonic effect on the plant from seed treatment with Leytosan P. The difference in the growth between the treated plants and the controls of different varieties was considered due more to the protection offered the food reserves in the cotyledons rather than to stimulation as a result of seed treatment.

7. Differences in response of different varieties to seed treatment were measured chiefly by the emergence differences though in one experiment growth measurements were also made. The relationships were similar for the two methods. It is considered that in both cases the differences are attributable to seed protection rather than to stimulation. The food reserves in the cotyledons of some varieties evidently are more readily attacked by micro-organisms than those of other varieties. Hence the former respond more to seed treatment than the latter.

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